Estimation of Smolt Production and Harvest of Stikine River Chinook Salmon, 2015

by

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and

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April 2015

Alaska Department of Fish and Game   **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	$(F, t, \chi^2,$ etc.$)$
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

REGIONAL OPERATIONAL PLAN SF.1J.2015.04

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Project Title: Estimation of smolt production and harvest of Stikine River Chinook salmon, 2015

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Division, Region and Area Sport Fish, Region I, Douglas
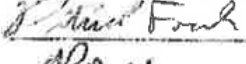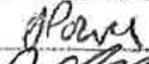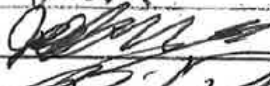
Project Nomenclature: Pacific Salmon Commission CWTIT; Chinook Salmon Research Initiative

Period Covered April–June, annually, 2015-2020

Field Dates: April 15–June 1, 2015-2020

Plan Type: Category III

Approval

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Chinook Salmon Research Initiative Approval
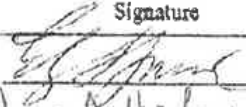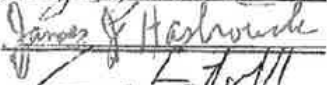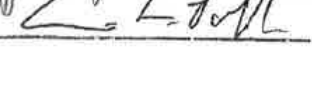
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ABSTRACT

The primary goals of this study are to estimate the number of Chinook salmon *Oncorhynchus tshawytscha* smolt leaving the Stikine River in 2015, and the harvest of adult Chinook salmon returning to the Stikine River from the 2013 brood year. A modified Petersen 2-event mark-recapture project will be used to estimate smolt abundance, and a coded wire tag project in conjunction with harvest sampling programs will be used to estimate harvest. Chinook smolt will be marked with adipose fin clips and coded wire tags in spring of 2015. Marked fish will be recaptured through creel, port, and escapement sampling programs. The Alaska Department of Fish and Game and Fisheries and Oceans Canada use these data, along with adult escapement information, to make terminal and regional management decisions, and the Pacific Salmon Commission uses the data for coastwide management and stock assessment through the Chinook Technical Committee.

Key words: Chinook salmon, adult production, smolt production, coded wire tag, Petersen estimator, marine survival, exploitation, mark-recapture, inriver run, escapement, total run, age composition, Stikine River.

PURPOSE

The primary goals of this study are to estimate a) the number of Chinook salmon smolt (≥50 mm FL) leaving the Stikine River in 2015 and b) the harvest of adult Chinook salmon returning to the Stikine River from the 2013 brood year. A modified Petersen 2-event mark-recapture project will be used to estimate smolt abundance and a coded wire tag (CWT) project relying on harvest sampling programs will be used to estimate harvest. Chinook smolt will be marked with adipose fin clips and CWTs in spring of 2015. Marked fish will be recaptured through creel, port and escapement sampling procedures. The Alaska Department of Fish and Game (ADF&G) and Department of Fisheries and Oceans Canada (DFO) use these data, along with adult escapement information (see separate operational plan), to make terminal and regional management decisions, and the Pacific Salmon Commission (PSC) uses the data for coastwide management and stock assessment through the Chinook Technical Committee (CTC).

The Alaska Department of Fish and Game has chosen the Stikine River as 1 of the 12 statewide Chinook salmon indicator stocks. The lack of stable funding for the juvenile Chinook salmon CWT program has been identified as problematic to the stock assessment program as a whole. Stable funding for the current CWT program is essential in producing the production parameter estimates mentioned above. These population characteristics can be tailored for strategies to achieve management objectives while providing fishing opportunities to various user groups.

BACKGROUND

The Stikine River is a transboundary river (TBR), originating in British Columbia and flowing to the sea near Wrangell, Alaska. The river is one of the largest producers of Chinook salmon *Oncorhynchus tshawytscha* in Northern British Columbia/Southwest Yukon Territory and Southeast Alaska (SEAK). It is one of three TBR systems that produce major runs of Chinook salmon, the terminal runs of which are jointly managed by ADF&G and DFO. The current ADF&G assessment is that Chinook salmon stocks in the Stikine River have rebounded from overfishing and low survival rates in the 1970s (Bernard et al. 2000). In February 2005, an agreement was negotiated between the U.S. and Canada by the Transboundary Rivers Panel and approved by the PSC for directed harvest of wild Chinook salmon returning to the Stikine River (Annex IV, Paragraph 3). Directed commercial fisheries were re-established in District 108 (U.S.) and the lower Stikine River (Canada) in 2005. Approximately 51,000, 44,000, 28,000, 17,000, and 9,000 large (≥660 mm MEF) Stikine River Chinook were harvested within all fisheries in 2005, 2006, 2007, 2008, and 2012, respectively (Richards et al. 2012; Jaecks et al. *in*

prep a–d). In 2009, 2010, 2011, and 2013 the terminal run was not large enough to allow directed fisheries but 4,000, 5,000, 6,000 and 5,000 large Chinook were subsequently captured in all fisheries during these years. Based on the current U.S.-Canada harvest sharing agreement, directed commercial fisheries may occur in the U.S. and Canada when the preseason terminal run forecast exceeds 28,100 fish. The 2015 joint forecast of 30,200 large Chinook is above the preseason trigger run size (28,100) but directed fisheries are unlikely in the U.S. in 2015 as this forecast only allows a US catch of 210 preseason according to the catch-sharing agreement mentioned above. However if inseason run size estimates exceed the inseason trigger of 24,500 large Chinook, directed fisheries may be prosecuted.

Chinook salmon escapement to the Stikine River has been monitored since 1975 by counting spawners at the Little Tahltan River, and Andrew Creek. A cooperative mark-recapture program between the ADF&G, DFO and the Tahltan First Nation (TFN) was begun in 1996 to estimate Chinook salmon escapement to the Stikine River (Pahlke and Etherton 1998), and is continuing. The estimated spawning escapement of large Chinook salmon has ranged from about 11,256 to 63,523 since 1996 (Table 1). All Chinook salmon less than 660 MEF, which are almost entirely "Jack" (male) Chinook salmon, are not included in the above estimates and comprise an additional 5% to 20% of the above numbers, depending on the year and brood strength. Results from this program were used to develop the current escapement goal of 14,000 to 28,000 large spawners in 2000 (Bernard et al. 2000). As part of that analysis, a revised expansion factor of 5.15 (SE = 0.77) for Little Tahltan River weir counts was also estimated, recognizing that 19% of the drainage wide escapement is estimated to be counted through this weir.

The CWT program designed to estimate smolt production and harvest of Stikine River Chinook salmon has been going on for over a decade (Table 2). The CWT-based harvest estimation will complement a genetic stock identification (GSI) program initiated in 2005 that independently estimates the contribution of the Stikine River stock to the commercial gillnet harvest in districts 106 and 108, and in the troll and sport fisheries occurring throughout the region. For PST purposes and harvest recording, GSI methods are used to determine harvest proportions. However, GSI and CWT estimates have been similar since 2005 and for the purposes of this research we will use the CWT estimates as they continue to be germane to the rest of the data. Improved stock identification, whether by CWTs or GSI is a critical element in the strategy to improve stock assessment and management of Chinook salmon, as outlined in Attachment F to the 1996 U.S. Letter of Agreement (LOA), the 2008 Pacific Salmon Treaty agreement, and U.S. coastwide Chinook salmon stock assessment standards (PSC 1997). Stock identification programs provide stock specific harvests, from which total adult production, exploitation rates, harvest distribution and survival parameters are estimated. These data are being used to improve planning and implementation related to: 1) regional management by ADF&G; 2) terminal run management by ADF&G and DFO; and 3) coastwide management in the PSC process.

Table 1.–Estimated spawning escapement of large (≥660 mm MEF) Stikine River Chinook salmon versus Little Tahltan River weir counts, 1996–2014.

Year	Estimated spawning escapement, large Chinook	Weir count, large Chinook	Weir count as % of estimated spawning escapement	Source
1996	28,949	4,821	17	Pahlke and Etherton (1998)
1997	26,996	5,557	21	Pahlke and Etherton (1999)
1998	25,968	4,879	19	Pahlke and Etherton (2000)
1999	19,947	4,738	24	Pahlke et al. (2000)
2000	27,531	6,640	24	Der Hovanisian et al. (2001)
2001	63,523	9,728	15	Der Hovanisian et al. (2003)
2002	50,875	7,490	15	Der Hovanisian et al. (2004)
2003	46,824	6,492	14	Der Hovanisian et al. (2005)
2004	48,900	16,381	33	Der Hovanisian et al. (2006)
2005	39,806	7,253	18	Richards et al. (2008)
2006	24,405	3,860	16	Richards et al. (2012)
2007	14,560	562	3	Richards et al. (2012)
2008	18,352	2,634	15	Richards et al. (2012)
2009	12,803 [a]	2,245 [a]	18 [a]	Jaecks et al. (*in prep* a)
2010	15,116 [a]	1,057 [a]	7 [a]	Jaecks et al. (*in prep* b)
2011	14,480 [a]	1,754 [a]	12 [a]	Jaecks et al. (*in prep* c)
2012	22,327 [a]	720 [a]	3 [a]	Jaecks et al. (*in prep* d)
2013	16,737 [a]	878 [a]	5 [a]	Jaecks et al. (*in prep* e)
2014	24,360 [a]	169 [a]	0.7 [a,b]	Jaecks et al. (*in prep* f)

[a] Preliminary
[b] Due to a slide in May 2014 on the lower Tahltan River, upstream migration was severely impacted

The CTC of the PSC models coastwide Chinook salmon abundance, through analysis of terminal runs, age structure, and exploitation rates derived from CWT recoveries for specific stocks. At present, abundance indices for the five largest stocks harvested in SEAK, including the Stikine River, are not included in the CTC model because neither a CWT nor GSI database is available for many of these stocks, and because of CTC workload issues. ADF&G has developed a database for these five stocks, which will eventually be incorporated into the CTC Chinook model. Implementation of the smolt tagging and adult escapement projects will enable production parameters such as harvest, escapement, exploitation rate, smolt production, and brood year production to be directly estimated in the future. The CTC, ADF&G and DFO will use this information to improve the assessment and predictions of wild spring Chinook stocks, which are important contributors to the SEAK fishery.

Table 2.–Juvenile Chinook salmon captured and marked with coded wire tags on the Stikine River, Southeast Alaska, 2000–2014.

Tag code	Brood year	Stage	Mean weight	Mean length	Year released	Date last released	Clipped and tagged	Clipped and not tagged	Total released
40357	1998	SMOLT	5.2	74	2000	6/13/2000	9,715	10	9,725
40358	1998	SMOLT	5.2	74	2000	5/30/2000	1,842	0	1,842
40359	1998	SMOLT	5.2	74	2000	6/13/2000	3,003	9	3,012
		Cumulative brood year total					14,560		
40459	1999	SMOLT	5.5	75	2001	6/1/2001	5,774	17	5,791
		Cumulative brood year total					5,774		
40533	2000	SMOLT	6.3	77	2002	6/1/2002	10,953	44	10,997
40534	2000	SMOLT	6.3	77	2002	6/13/2002	6,458	13	6,471
		Cumulative brood year total					17,411		
40802	2001	SMOLT	4.9	72	2003	5/28/2003	11,269	34	11,303
40803	2001	SMOLT	4.9	72	2003	6/9/2003	8,658	17	8,675
		Cumulative brood year total					19,927		
40804	2002	SMOLT	4.4	71	2004	5/11/2004	11,351	46	11,397
40956	2002	SMOLT	4.4	71	2004	5/21/2004	11,387	46	11,433
40957	2002	SMOLT	4.4	71	2004	5/30/2004	3,892	0	3,892
		Cumulative brood year total					26,630		
41130	2003	SMOLT	4.5	72	2005	5/11/2005	10,822	54	10,876
41131	2003	SMOLT	4.5	72	2005	6/2/2005	10,862	0	10,862
		Cumulative brood year total					21,684		
41148	2004	SMOLT	3.8	71	2006	5/31/2006	7,783	16	7,799
41149	2004	SMOLT	3.8	71	2006	5/26/2006	6,645	0	6,645
41297	2004	SMOLT	3.8	71	2006	5/8/2006	10,592	21	10,613
41298	2004	SMOLT	3.8	71	2006	5/13/2006	11,062	33	11,095
41299	2004	SMOLT	3.8	71	2006	5/17/2006	11,166	22	11,188
		Cumulative brood year total					47,248		
41132	2005	SMOLT	3.6	70	2007	5/22/2007	11,610	12	11,622
41469	2005	SMOLT	3.6	70	2007	5/28/2007	10,847	44	10,891
41470	2005	SMOLT	3.6	70	2007	5/28/2007	1,302	8	1,310
		Cumulative brood year total					23,759		
41471	2006	SMOLT	4.1	73	2008	5/14/08	23,042	69	23,111
41547	2006	SMOLT	4.1	73	2008	5/29/08	9,702	0	9,702
41551	2006	SMOLT	4.1	73	2008	5/19/08	11,268	23	11,291
		Cumulative brood year total					44,012		
41781	2007	SMOLT	4.4	74	2009	5/21/2009	11,776	0	11,776
41782	2007	SMOLT	4.4	74	2009	5/26/2009	6,821	0	6,821
41788	2007	SMOLT	4.4	74	2009	5/15/2009	23,459	0	23,459
		Cumulative brood year total					42,056		
41533	2008	SMOLT	4.3	73	2010	5/28/2010	6,706	0	6,706
41534	2008	SMOLT	4.3	73	2010	5/28/2010	5,932	0	5,932
41555	2008	SMOLT	4.3	73	2010	5/20/2010	22,386	0	22,386
		Cumulative brood year total					35,024		
41024	2009	SMOLT	5.1	81	2011	5/26/2011	21,853	22	21,875
41519	2009	SMOLT	5.1	81	2011	5/26/2011	9,232	0	9,232

-continued-

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Table 2.–Page 2 of 2.

Tag code	Brood year	Stage	Mean weight	Mean length	Year released	Date last released	Clipped and tagged	Clipped and not tagged	Total released
41524	2009	SMOLT	5.1	81	2011	5/24/2011	1,084	0	1,084
		Cumulative brood year total					32,169		
42965	2010	SMOLT	5.9	77	2012	5/21/2012	21,402	43	21,445
42966	2010	SMOLT	5.9	77	2012	5/26/2012	10,517	74	10,591
42977	2010	SMOLT	5.9	77	2012	5/29/2012	1,511	0	1,511
		Cumulative brood year total					33,430		
43047	2011	SMOLT	4.6	74	2013	5/8/2013	11,031	0	11,031
43048	2011	SMOLT	4.6	74	2013	5/11/2013	11,278	0	11,278
43049	2011	SMOLT	4.6	74	2013	5/15/2013	11,411	0	11,411
43069	2011	SMOLT SMOLT	4.6	74	2013	5/22/2013	11,226	0	11,226
43353	2011	SMOLT	4.6	74	2013	5/27/2013	3,501	0	3,501
		Cumulative brood year total					48,447		
43564	2012	SMOLT	3.9	71	2014	5/11/2014	21,490	0	21,490
43565	2012	SMOLT	3.9	71	2014	5/15/2014	11,112	0	11,112
43583	2012	SMOLT	3.9	71	2014	5/26/2014	9,115	0	9,115
		Cumulative brood year total					41,717		

PRIMARY OBJECTIVES

1. Estimate the number of Chinook salmon smolt ≥50 mm fork length (FL) leaving the Stikine River in 2015 such that the estimated number is within 25% of the true value 95% of the time.

2. Estimate the total U.S. harvest of Stikine River Chinook salmon from the 2013 brood year (via recovery of CWTs applied in 2015) such that the estimated number is within 30% of the true value 95% of the time.

SECONDARY OBJECTIVES

1. Estimate the mean length of Chinook salmon smolt ≥50 mm FL captured in 2015 such that the estimated mean is within 1 mm of the true mean 95% of the time.
2. Estimate the mean weight of Chinook salmon smolt to the nearest 0.1 g captured in 2015 such that the estimated mean is within 0.1g of the true mean 95% of the time.
3. Estimate the exploitation and marine survival (smolt to adult) rates for the 2013 brood, assuming reliable estimates of harvest of Stikine River stocks in 2016–2020.

Estimation of the above parameters will allow us to describe total adult production, exploitation rates, and survival rates. Annual length and weight data for smolt may allow us to examine the optimum smolt production for the system and provide additional information for escapement goal analysis.

METHODS

CHINOOK SALMON SMOLT ABUNDANCE IN 2015

A mark-recapture experiment will be used to estimate the abundance of Chinook salmon smolt

emigrating from the Stikine River in 2015. Smolt will be tagged and marked in 2015 as the first of two sampling events. Returning adult Chinook salmon will be inspected inriver for marks in 2016 through 2020 as the second sampling event.

Chinook salmon smolt will be captured with beach seines and baited minnow traps by three to four 3-person crews in the 20 km of the mainstem Stikine River upstream of the international border (56.65469, -131.84884) ending at the mouth of Choquette Creek that flows into the Stikine River opposite of the Great Glacier (56.81153, -131.78543) (Figure 1). Approximately 200 baited minnow traps will be fished and checked daily beginning about April 20, 2015. When the outmigration commences in early May, beach seining effort will be increased and trapping will be limited to maximize catch. Project staff will assist with CWT operations during this period to ensure timely tagging of captured smolt.

All healthy Chinook salmon smolt ≥50 mm FL will be tranquilized with a buffered MS 222 solution, injected with a CWT, and have their adipose fin removed (Magnus et al. 2006). All marked (CWT-tagged) Chinook salmon smolt will be released near the DFO camp. Before release, 100 fish from the holding pens will be checked for tag retention and the entire catch in the net pens will be checked for overnight mortality.

Sampling targets for Chinook salmon smolt are based on historical smolt abundance estimates and the number of adults inspected for missing adipose fins in joint ADF&G and DFO gillnet operations at Kakwan Point, Canadian inriver fisheries (aboriginal, commercial, test and sport), and at or near spawning locations in Canada (Little Tahltan River weir, Verrett River). We will inspect adults for missing adipose fins from 2016 through 2020 (ages 1.1 to 1.5; European age notation).

We have inspected an average of 5,048 (range 2,695 to 8,373) returning adults (age 1.1 to 1.5) from the 2000 to 2006 brood years and the average smolt abundance estimate for these brood years is 3,000,000 (range 2.2 to 4.4 million). Therefore, according to Robson and Regier (1964), we need to tag about 40,900 Chinook smolt to meet the criteria in Objective 1. In 2014, we exceeded this number by tagging 41,998 Chinook salmon smolt (Table 2). Due to recent poor Stikine River Chinook salmon returns and poor marine survival from the 2003 to 2006 brood years, and failure to meet objectives when tagging over 40,900 smolt for the 2004 brood year, we will aim to tag at least 40,900 Chinook salmon smolt in 2015, and to continue tagging beyond this minimum as long as conditions are favorable.
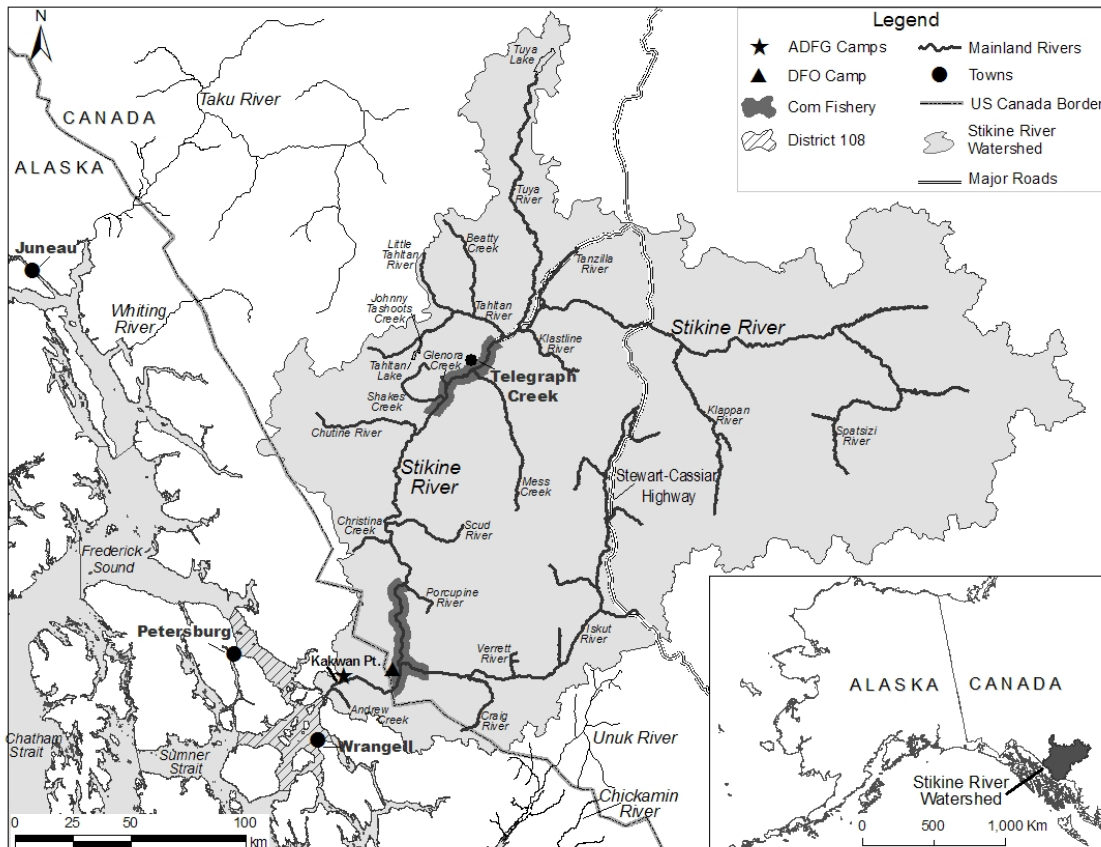
Figure 1.–Stikine River drainage in Southeast Alaska, showing detail of study area.

MEAN LENGTH AND WEIGHT OF CHINOOK SALMON SMOLTS IN 2015

A systematically drawn sample of 384 Chinook salmon smolt ≥50 mm FL will be collected to meet criteria for length and weight in Secondary Objectives 2 and 3. Based on data collected from the Stikine River in 2006, the standard deviation of the fork lengths of Chinook salmon smolt from the Stikine River is estimated at 10 mm. According to procedures in Thompson (2002), the sample size to meet objective criteria is $[(1.96)(10)/(1)]^2$. Based on an expected catch of 40,900 Chinook smolt (see above), about every 100th smolt captured should be measured for length to the nearest mm FL (and measured for weight to the nearest 0.1 gram). To achieve this without disrupting tagging operations and to reduce bias, a subsample of the 100 tagged smolt that are checked daily for CWT retention will be measured and weighed before release. The length weight data (often expressed as a condition factor) along with estimates of smolt production and spawner recruit data may provide another way of evaluating optimum escapement. Both of these factors when modelled against a variety of environmental factors could enlighten researchers to production bottle necks.

HARVEST OF CHINOOK SALMON FROM THE 2013 BROOD YEAR

Chinook salmon from the Stikine River are almost all (95% to 100%) from a single freshwater age, overwintering 1 year as fry and emigrating as age-1 (total age 2) smolt (Richards et al. 2012). Any smolt that are tagged are essentially from 1 brood year, e.g., Chinook salmon smolt tagged in 2015 are from the 2013 brood year. The return of adult Chinook salmon from the 2013 brood year encompasses 5 years, beginning with age-1.1 "jacks" in 2016 and ending with age-1.5 fish in 2020.

Recovery of CWT-tagged Chinook salmon in the various fisheries through 2020 will be used to estimate the total harvest of Chinook salmon from the Stikine River for the 2013 brood year. Tagging 40,000 Chinook salmon smolt in 2015 should provide an estimate of harvest with a 95% relative precision of about 23%, meeting the criteria in Objective 2 (95% relative precision of ≤30%), according to procedures in Bernard et al. (1998).

This judgment is based on: 1) recent inspection of statistics by harvest stratum (average of about 35%) of commercial and sport harvests in marine fisheries where Stikine-origin fish occur; 2) approximately 3 million smolt leaving the Stikine River in 2015 (see smolt abundance section); 3) anticipated stratum-specific total harvests and variance (if a sport harvest); and 4) anticipated stratum-specific Stikine River tag recoveries.

A simulated data set to anticipate harvest and its variance from the 2013 Stikine Chinook salmon brood is shown in Appendix A1. The appendix is based on the above numeric and sampling assumptions for the 2013 brood, inferred from past recoveries of Stikine River CWTs from the 2000–2002 broods. Given that we anticipate tagging about 40,000 smolt in 2015, precision for the estimate of harvest from the 2013 brood should be at least that shown in Appendix A1 (expected 95% relative precision for U.S. marine harvest is 23%). We anticipate, under current fishing regimes, 14% of the harvest to be taken in the sport fishery, 16% in the troll fishery, and 70% in the gillnet fisheries. We anticipate recovery of 89 CWTs in U.S. marine fisheries given 40,000 smolt tagged and the above assumptions. Note that all U.S. marine harvests are estimated from sampling a percentage of the U.S. sport and commercial harvests. Protocols for the collection of data from adult Chinook salmon at Kakwan Point and in the marine and inriver fisheries can be found in operational plans developed by ADF&G and DFO.

Based on the methodology in Bernard et al. (1998), the probabilities of recovering a least 1 tag in each individual stratum varied from 2% to almost 100%. The product of the probabilities of all 51 strata listed in Appendix A1 indicate a 100% chance (risk) of not recovering a CWT in each of the 51 strata; however 9 of those strata are anticipated to account for 46% of the harvest and we stand about a 90% chance of recovering at least 1
tag from each of those strata. Increasing the number of smolt tagged reduces the risks of not recovering tags, so we will tag as many smolt as possible during this study.

The analysis of estimated harvest of Stikine Chinook salmon from the 2002 brood year are shown in Appendix A2. Estimating harvest with a relative precision of 25% appears to have been met with a total of 26,630 CWT-tagged smolt and 8,373 adults inspected inriver for the 2002 brood year. About 55% of the harvest was taken in gillnet fisheries, 32% in troll fisheries and 10% in sport fisheries.

SAMPLING HISTORY AND SUMMARY

In 2000, the first year of this project, we captured approximately 14,700 Chinook salmon smolt and released about 14,600 with tags (Table 2). In 2001, we deployed more traps (about 200 versus 160) and hoped to capitalize on the experience and knowledge acquired during the first year of this project (e.g., location of productive trapping areas, migration timing, etc.), but only released about 5,770 smolt with tags. Reasons for the poor catch rates are unknown. In 2002, we tagged and released approximately 17,400 Chinook salmon smolt. About 15,000 of these were collected with beach seines, which proved to be particularly effective during high water when minnow traps could not be deployed. In 2003, an additional seining crew was added. About 19,900 smolt were tagged in 2003, 26,600 in 2004, and 21,700 in 2005. In 2006, we tagged 47,000 smolt due in part to redirecting efforts to intensive seining during peak. A record snow pack and difficult fishing conditions in 2007 resulted in a catch of only 23,759. In 2008, we tagged 44,000 smolt, 42,000 in 2009, 35,024 in 2010, 32,169 in 2011, 33,574 in 2012, 48,447 in 2013, and 41,717 in 2014.

In summary, our goal is to tag a minimum of 40,900 Chinook salmon smolt in 2015. If at least 40,000 Chinook salmon smolt are tagged, we expect to meet or exceed precision requirements identified in Primary Objectives 1 and 2. In 2015 we plan to maintain the same level of seining effort during peak migration but will also continue to increase efficiency of crew schedules, and to focus on the most productive areas we found in previous years.

DATA COLLECTION

All healthy Chinook salmon smolt ≥50 mm FL without CWTs will be tranquilized with a buffered MS 222 solution, tagged with a CWT following procedures described in Magnus et al (2006), and have their adipose fin removed. Chinook smolt less than 50 mm are very fragile and they will not be tagged to avoid increased mortality of released smolt. Any smolt captured that have missing adipose fins prior to tagging will be passed through a magnetic tag detector, and the presence or absence of a CWT will be recorded. A systematic sample of smolts will be measured to the nearest mm FL (and weighed to the nearest 0.1 g). All newly tagged fish will be held overnight to test for post-tagging mortality and a portion (100 from each tagging event) will be tested for tag retention; see below for details on action taken in event of mortality or tag retention problems. All smolt will be released near the DFO camp.

The following tag codes will be used in 2015:

Spool size	Tag code
20K	Unknown
10K	Unknown
10K	Unknown

Codes used will be recorded on an **ADF&G TAGGING SUMMARY AND RELEASE INFORMATION** form provided by ADF&G Division of Commercial Fisheries (CF) Mark, Age, and Tag Laboratory (Tag Lab); a 5 cm section from each spool of coded wire will be taped to the form the first day of tagging with a new tag code. A new **TAGGING SUMMARY AND RELEASE INFORMATION** form will be used for each tag code. If one roll of coded wire is depleted during a session, a new **TAGGING SUMMARY AND RELEASE INFORMATION** form will be filled out, and a piece of wire from the new spool will be attached to the form. Information on this form will be used to estimate the number of smolt that survived tagging and retained CWTs. Guidelines in the CWT manual provided by the Tag Lab will be used to complete this form.

All tag and recapture data will be recorded daily on the form entitled **SPORT FISH DIVISION SALMON SMOLT CWT DAILY LOG** (**DAILY LOG** (Appendix B1). The data on the **DAILY LOG** form will be used to record environmental data, catch, tagging, release, and recapture data for each day's session. A separate **DAILY LOG** form will be filled out for each day of operation.

Daily procedures will be as follows:

1.   Record location, date, and species on the **DAILY LOG** form
2.   Record water and air temperature to nearest °C, water depth to nearest cm, and precipitation to the nearest mm on the **DAILY LOG** form. Data should be collected at 0730 hours each day.
3.   At 0700–0730 hours mix the fish in the holding net pen and check 100 representative smolt for tag retention and record on the **DAILY LOG** form. If tag retention is 98% or greater, empty the net, count and record mortalities, and transport approximately 3 km to the release site at the U.S.\Canada border which is approximately 100 m downriver of all seining operations,and release all fish. If tag retention is 97% or less, reprocess the entire batch and retag any that test negative for CWTs. Also adjust tagging procedures, e.g., sharpen needles, adjust tag depth, or change head molds to increase the rate to 100%.

4.   Check the minnow trap line and/or beach seine and transport fish to camp. Place fish in net pens designated for trap-caught or beach-seined fish. Sort Chinook salmon from other species. Inspect each live fish and count the number with adipose clips and record the number under "Recaptures" on the **DAILY LOG** form. Test all recaptures for tag retention. Retag any recaptures that test negative and record them as retags. Record results of tag retention for recaptures on the **DAILY LOG** form.

5.   Give all untagged healthy Chinook salmon smolt ≥50 mm FL a CWT and pass each through the tag detector. If rejected by the detector, retag and tally all retags on a hand counter. Write the beginning and ending machine numbers on the **DAILY LOG** form and record retags, mistags (goofs, misses, etc), and practice tags. Show your calculations for the number of tags issued for each tag code for each day. Hold all fish overnight for tag retention and short-term mortality evaluation.

6.   Draw a random sample from tagged Chinook salmon smolt during tag retention protocols so that the sample is at least .01 of the previous days tagging total. Measure to the nearest mm FL (and weigh to the nearest 0.1 gram), and record all data on the **SMOLT AWL DATA** form (Appendix B2). Also record the capture method, i.e., trap or seine.

7.   Fill out the **CWT SUMMARY DATA** (Appendix B3; valid releases only) form daily. The project biologist will submit the **TAGGING SUMMARY AND RELEASE INFORMATION** forms to the Tag Lab via the Online Release Entry program postseason.

Returning adults from 2016 until 2020 will be inspected for clipped adipose fins denoting a CWT. Data for documenting the fraction of the escapement bearing valid CWTs and adipose fin clips will be recorded on a **HATCHERY RACK AND ESCAPEMENT SURVEY** form (provided by the Tag Lab) each day adult sampling occurs at Kakwan Point or Andrew Creek. Sampling data collected from the Canadian inriver fisheries or spawning grounds will be recorded by DFO on forms provided by their tag lab. Heads will be taken from all adult Chinook salmon missing adipose fins, and a uniquely numbered cinch strap will be attached to each head. Capture site, date, gear, sex, length (MEF), and head number (off the cinch strap) will be recorded by field crews on field data forms and Rite-n-Rain™[1] labels. Each cinch tagged and clearly labeled head will be shipped to ADF&G in Douglas or DFO in Whitehorse depending on the sampling site (i.e., a site in the U.S. or Canada). If shipment is delayed and refrigeration is unavailable, heads will be preserved with salt or borax. Depending on sampling location, project leaders will complete either the **HATCHERY RACK AND ESCAPEMENT SURVEY** form (as provided by the Tag Lab) or the corresponding DFO form, and include them with head shipments to each agency's respective tag lab.

A scale sample will also be taken from every adult Chinook salmon observed during sampling that is missing the adipose fin to verify brood year. Scales will also be sampled from every Chinook salmon caught at Kakwan point and from a representative sample of inspected fish from the escapement surveys and lower river commercial fishery. Scales will be taken from the left side of the fish from the preferred area (2 rows up from the lateral line at the bottom of a diagonal from the posterior end of the insertion of the dorsal fin) according to the procedures in Welander (1940). Five scales will be taken from each fish and mounted on gum cards for later impression into acetate.

DATA REDUCTION

The field crew leader will record and error check all data. Data forms (primary data capture) will be kept up to date at all times. Data will be sent to the office at least three times per week and inspected for accuracy and compliance with sampling procedures. Data will be transferred from field books or forms to EXCEL™ spreadsheet files (secondary data capture). When input is complete, data lists will be obtained and checked against the original field data.

Electronic data files will be used to check tagging totals with field notebooks, to identify lengths less than prescribed guidelines, sampling rates for age, length, and weight, and for data on the **TAGGING SUMMARY AND RELEASE INFORMATION and HATCHERY RACK AND ESCAPEMENT SURVEY** forms.

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[1] This and subsequent product names are included for a complete description of the process and do not constitute product endorsement.

When the report is complete, copies of selected data and a data map will be sent to the Research and Technical Services (RTS) section for archiving. All adult data will be permanently archived on the Integrated Fisheries Database (IFDB) with CF in the Douglas Regional office. Completed **TAGGING SUMMARY AND RELEASE INFORMATION and HATCHERY RACK AND ESCAPEMENT SURVEY** forms will be sent to the Tag Lab, which is the permanent repository for all CWT data for the State of Alaska. Yearly, the Alaskan CWT data is transferred to the Pacific States Marine Fisheries Commission, which stores coastwide CWT data in a permanent and standardized database.

Catches of smolt and adult Chinook salmon, numbers tagged, and fish missing adipose fins will be tabulated by day. Scale ages will be used to verify brood year. CWT codes from recovered adult Chinook salmon will be used to verify stock origin.

DATA ANALYSIS

Chinook Salmon Smolt Abundance in 2015

The mark-recapture experiment will use Chapman's modification of the Petersen method (Seber 1982) to estimate abundance of smolt and its variance. Smolt will be tagged and marked in 2015 as the first of two sampling events. Returning Chinook salmon will be inspected for marks in 2016 through 2020 as the second sampling event to determine the marked fraction. The relationships among brood, tagging and adult return years are shown in Table 3, where n_i is the estimated number of adults sampled from the river that are from brood year 2013 and of ocean age i, $m_{.i}$ is the number of adults in that sample with missing adipose fins, t is the number of smolt tagged from brood year 2013, and $n.$ and $m.$ are the total numbers of adults and marked adults found in the sample from brood year 2013, respectively. Smolt abundance from brood year 2013 will be estimated using a 2-event, mark-recapture experiment with Petersen's estimator as modified by Chapman (1951):

$$\hat{N}_s = \frac{(t+1)(n.+1)}{m.+1} - 1 \tag{1}$$

Table 3.–Components of equation 1 for brood year 2013 Chinook salmon on the Stikine River, Southeast Alaska.

	Brood year	Tagging year	Age class and sampling year					Total
			1.1	1.2	1.3	1.4	1.5	
	2013	2015	2016	2017	2018	2019	2020	
Smolt tagged		t						
Estimated adults inspected[a] n_i			n_1	n_2	n_3	n_4	n_5	$n.$
Marked adults m_i			m_1	m_2	m_3	m_4	m_5	$m.$

[a] Not all adults sampled for adipose fin clips and CWTs are sampled for age. Entries are calculated as the product of lower harvest, spawning ground sample, or Kakwan Point catch and appropriate age proportions.

Adults inspected will come from 3 sources (*see* Richards et al. 2012): 1) adults caught in the tagging event of the annual Stikine River mark-recapture project; 2) adults caught and sampled from the Canadian inriver fisheries; and 3) adults captured and sampled on spawning grounds during the recovery event of the annual mark-recapture project.

As a result of sampling variability in estimates of the number of each age class inspected (n_i), the variance of $\hat{N}_s$ will be estimated through Monte Carlo simulation. The number of fish examined by brood year will be simulated with a normal distribution $N(n., \text{var}(n.))$, and the number of clips found will be simulated with a binomial distribution $(n., m./n.)$. Equation 1 will be used to generate simulated values of $\hat{N}_s$ and a sample variance taken of the generated values. The quantity $\text{var}(n.)$ will be calculated by summing annual estimated variances of estimated inspected fish for the respective recovery years. (Annual estimates originate from independent sampling events).

The conditions for accurate use of the Petersen methodology are:

1. all smolt have an equal probability of being marked in 2015; <u>or</u>

2. all adults have an equal probability of being inspected for marks in 2016 through 2020; <u>or</u>

3. marked fish mixed completely with unmarked fish in the population between years; <u>and</u>

4. there is no recruitment to the population between years; <u>and</u>

5. there is no trap induced behavior; <u>and</u>

6. fish do not lose their marks and all marks are recognizable.

Condition1: Minnow traps and beach seines will be continuously deployed during smolt emigrations, and while minnow traps are thought to be biased toward large smolt, they also constitute less than 5% of our yearly catch and beach seines are not considered size-selective. High water events, and to a lesser degree, missing the very beginning of the outmigration of smolt may preclude all smolt having an equal probability of capture however it is believed this will not lead to large biases.

Condition 2: If migratory timing of smolts are unrelated to that of adults, it is likely that significant mixing of marked and unmarked smolt will have occurred in the population prior to their return as adults. When sufficient adult CWT Chinook salmon are encountered, we will assess the degree of mixing by comparing the order in which tag codes are applied to smolts with the order of codes we find in returning adults. We will also test for temporal changes in the fraction of adults missing adipose fins: if either condition 1 or condition 3 has been met, this fraction will not change with time. It is noted that changing marked fractions in adults over time can be consistent with condition 2; condition 2 states that a random sample of adults is taken and makes no assumption about changing marked fractions over time in the population. Temporal chances in the marked fractions will be tested against a χ^2 distribution.

Condition 3: Adult immigrations will be sampled almost continuously in gillnet catches during tagging operations. This relatively constant sampling effort will tend to equalize the probabilities of capture for all fish passing the international border. However gillnets are size selective, and since some but not all spawning grounds are sampled, fish that spawn on those grounds have a

higher probability of capture. Still if either condition 1 or 2 is met, or if the bias from gillnet size, or spawning ground inspections are small the necessary conditions will be met.

Condition 4: Almost all surviving smolts return to their natal stream as adults to spawn, so there will be no meaningful recruitment added to the population of "smolts" while they are at sea.

Condition 5: Results from other studies (Elliott and Sterritt 1990; Vincent-Lang 1993) indicate that excising adipose fins and implanting CWTs will not increase the mortality of marked salmon, provided that care is taken in handling them until release back into the river. Tagging practices will be monitored frequently through the overnight mortality and tag loss assessments.

Condition 6: Adipose fins will be removed from all CWT-tagged smolt, clips will be double checked prior to tagging as a means of quality control, and recovery personnel will carefully examine returning adults for missing adipose fins.

The mark-recapture experiment to estimate the abundance of Chinook salmon smolts is complicated by adults returning not in 1 year, but over five. Chinook salmon marked in 2015 will return from 2016 through 2020. Each year there will be an opportunity to estimate the fraction of the population that had been marked in 2015. In 2016, only fish age 1.1 (estimated from scale analysis) will be used to estimate smolt abundance in 2015. In 2017, estimated abundance of smolt will be updated with data collected from fish aged 1.2. If θ is the fraction of the population originally marked, the null hypothesis $H_o: \theta_{1.1} = \theta_{1.2}$ will be tested against a χ^2 distribution with 1 df. If the hypothesis is not rejected, data from 2016 and 2017 will be pooled and used to estimate abundance of smolt in 2015. This procedure will continue through 2020 for those Chinook salmon marked in 2015 as data and df accumulate. If H_o is rejected during any one of these years, the data will still be pooled if we believe the adult sampling has accessed the run in a consistent and representative manner among the sampling years. If we cannot assume representative sampling in the adult sampling phase, the estimated θ will be averaged over the years (instead of pooling all data) and its variance estimated accordingly as suggested in Seber (1982:114–115).

Mean Length and Weight of Chinook Salmon Smolts in 2015

Estimates of mean length and weight of Chinook salmon smolts and its variance will be calculated with standard sample summary statistics (Thompson 2002), unless there is a trend in the data (lengths or weights of smolt either increase or decrease through time). In that case, variance will be approximated according to the procedures in Wolter (1985):

$$v\left(\sum_{i=1}^{n} l_i / n \right) = \frac{\sum_{i=2}^{n} (l_i - l_{i-1})^2}{2n(n-1)} \tag{2}$$

Harvest of Chinook Salmon from the 2015 Brood Year

Harvest of Chinook salmon from the Stikine River will be estimated by year class through a stratified catch sampling program of commercial and recreational fisheries. Methods published in Bernard and Clark (1996: Table 2) will be used. Sampling variability in estimates of the number of each age class inspected (n_i) for CWTs will be incorporated in estimation of the variance of the inverse of the marked fraction through Monte Carlo simulation. Commercial catch data for the analysis will be summarized by ADF&G statistical week and district (for gillnet and seine

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fisheries), and by troll period and quadrant for troll fisheries. Sport fish CWT recovery data will be summarized by biweek (fortnight) and fishery (e.g., biweek 16 during the Sitka Marine Creel Survey). Harvest estimates for commercial fisheries will be obtained from the Region 1 Integrated Fisheries Database (IFDB) system, which tabulates and stores all records of fish tickets and sales receipts for commercially sold salmon. Sport harvest estimates from ADF&G Statewide Harvest Survey reports (e.g., Jennings et al. 2011) will be apportioned using information from sampled marine sport fisheries to obtain estimates of total harvest by biweek and fishery. Sport fish CWT recovery data will be obtained from CF Tag Lab reports and summarized by biweek and fishery (e.g., biweek 16 during the Sitka Marine Creel Survey) to estimate contribution. In most cases, CWTs of interest may be recovered in only a few of the sport fish sampling strata that defined the fishery biweek. Assuming that the harvests of fish with CWTs of interest are independent of sampling strata within fishery biweeks, harvests and sampling information will be totaled over the fishery biweek to estimate contributions.

The estimates will be based on information from sampling of (Bernard 1998):

1. number of Chinook salmon harvested;
2. fraction of the harvest inspected for missing adipose fins;
3. number of Chinook salmon in the sample with missing adipose fins;
4. number of fish heads that reached the tag and otolith lab;
5. number of these heads that contained CWTs;
6. number of these CWTs that were decodable; and
7. number of decodable tags of the appropriate code(s).

BUDGET

Details of the budget are contained in the state FY15Southeast CWT Improvement Team (CWTIT) proposal *Stikine River Chinook Smolt CWT*.

SCHEDULE AND DELIVERABLES

Field activities for smolt tagging will begin inriver approximately 17 April and extend through early June 2015. Field activities for recovering Chinook salmon with missing adipose fins will begin approximately early May and extend through August annually, 2016–2020. Data editing and analysis will be initiated before the end of each season. CWTIT progress reports summarizing smolt field activities, successes, and suggestions for improvement will be submitted by the U.S. project biologist by 9 July 2015. Data will be sent to RTS for archiving by September 2015.

REPORTS

An ADF&G, Division of Sport Fish Fishery Data Series (FDS) report will be prepared by 1 June 2021 summarizing smolt abundance and adult harvest. The same report will also be submitted under separate cover to the PSC.

RESPONSIBILITIES

I.   U.S. Personnel Responsibilities

Troy Jaecks, FB II. In concert with Peter Etherton sets up all aspects of project, including planning, budget, sample design, permits, equipment, personnel, and training. Will hire seasonal technicians and supervise entire ADF&G crew.

Philip Richards, FB III. Assists in project planning, budget, sample design, permits, equipment, personnel, and training. Assists in supervising field operations. Coalesces, edits, analyzes, and reports data; assists with fieldwork.

Ed Jones, Salmon Research Coordinator. Responsible for general oversight of project. Assists in planning project and writing operational plan.

Sarah Power, Biometrician II. Provides input to and approves sampling design. Coauthors operational plan and provides biometric details. Coauthors and assists with data analysis for the final report.

Stephen Todd, FB I. Responsible for logistics, resupply and general instruction to crew during camp set up and break down. Position will assist with fishing crews when sampling intensity requires. Will lead in equipment maintenance and resupply and logistics.

Vacant, FWT III. Will assist in data recording and editing, preparing weekly grocery/equipment needs list, and all aspects of field operations, including safe operation of riverboats, trapping, beach seining, tagging, data collection, and general field camp duties.

Laura Junge, FWT II. Will assist in equipment maintenance, and all aspects of field operations, including safe operation of riverboats, trapping, beach seining, tagging, data collection, and general field camp duties.

Kiana Putman, FWT II. Will work in all aspects of field operations, including safe operation of riverboats, trapping, beach seining, tagging, data collection, and general field camp duties

II.   Canadian Personnel Responsibilities

Peter Etherton. In concert with Jaecks, will assist in Canadian aspects of the program including tag recovery and report preparation. Will provide recovery data to ADF&G. Will review data, provide input into report, write sections regarding recovery, and serve as coauthor.

Melvin Besharah, Fishery Technician. Will assist in all aspects of field operations, including safe operation of riverboats, trapping, beach seining, tagging, data collection, and general field camp duties.

Clayton Tashoots, Fishery Technician. Will assist in all aspects of field operations, including safe operation of riverboats, trapping, beach seining, tagging, data collection, and general field camp duties.

Kyle Inkster/Drew Inkster, Fishery Technician. Will assist in all aspects of field operations, including safe operation of riverboats, trapping, beach seining, tagging, data collection, and general field camp duties.

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APPENDIX A

Appendix A1.–Statistics used to link the number of Chinook salmon to tag with the ultimate relative precision of the estimated harvest from adults returning to the Stikine River in 2017 (1.2) to 2019 (1.4) from the 2013 brood year. Terminology from Bernard and Clark (1996); see footnote legend.

$\phi = 0.33$ (average all marine fisheries); $\theta = 0.0133$ (40,000 tagged smolts; 3,000,000 smolt population); $var\left(\frac{1}{\hat{\theta}}\right) = 83$ (5000 adults sampled for tags)

Stratum	Age	Return year	N_i or $\hat{N}_i$	$V[\hat{N}_i]$	m_i	λ_t	$\hat{r}_i$	ϕ_i	$G(\hat{p}_i)$	$G(\hat{N}_i)$	$SE[\hat{r}_i]$	Prob($m_{ij} > 0$)
Gillnet U.S. Wk 19	1.2	2017	650	0	0.54	1.00	80	51%	1.83	0	108	0.420
Gillnet U.S. Wk 20			1,200	0	0.40	1.00	48	63%	2.46	0	75	0.332
Gillnet U.S. Wk 21			3,000	0	0.54	1.00	53	77%	1.82	0	71	0.420
Gillnet U.S. Wk 22			3,300	0	1.48	1.00	192	58%	0.67	0	158	0.773
Gillnet U.S. Wk 23			5,750	0	1.90	1.00	216	66%	0.52	0	157	0.851
Gillnet U.S. Wk 24			7,000	0	2.09	1.00	290	54%	0.48	0	202	0.876
Gillnet U.S. Wk 25			2,400	0	1.22	0.97	205	46%	0.81	0	185	0.705
Gillnet U.S. Wk 26			1,300	0	0.13	0.93	47	23%	7.45	0	127	0.125
Gillnet U.S. Wk 27			1,300	0	0.13	1.00	77	13%	7.48	0	209	0.125
Gillnet U.S. Wk 28			1,000	0	0.03	1.00	14	0.1	38.19	0	86	0.026
Gillnet U.S. Wk 29			400	0	0.03	1.00	12	0.2	34.64	0	70	0.028
Troll NW Spring	1.3	2018	16,000	0	3.04	0.99	604	0.4	0.33	0	351	0.952
Troll NW 1st			95,000	0	1.34	0.96	418	0.3	0.75	0	362	0.737
Troll NE Spring 109–112			10,000	0	0.90	0.98	144	0.5	1.10	0	151	0.594
Troll NE Spring 108			500	0	0.45	1.00	84	0.4	2.22	0	125	0.361
Troll NE Spring 108			1,500	0	0.45	1.00	78	0.4	2.22	0	116	0.361
Gillnet U.S. Wk 19			650	0	2.71	1.00	399	0.5	0.37	0	244	0.934
Gillnet U.S. Wk 20			1,200	0	2.02	1.00	240	0.6	0.49	0	170	0.867
Gillnet U.S. Wk 21			3,000	0	2.71	1.00	264	0.8	0.37	0	162	0.933
Gillnet U.S. Wk 22			3,300	0	5.35	1.00	692	0.6	0.19	0	308	0.995
Gillnet U.S. Wk 23			5,750	0	6.79	1.00	772	0.7	0.15	0	307	0.999
Gillnet U.S. Wk 24			7,000	0	7.36	1.00	1,022	0.5	0.13	0	393	0.999
Gillnet U.S. Wk 25			2,400	0	6.09	0.97	1,023	0.5	0.16	0	429	0.998
Gillnet U.S. Wk 26			1,300	0	0.67	0.93	236	0.2	1.48	0	287	0.489
Gillnet U.S. Wk 27			1,300	0	0.67	1.00	387	0.1	1.49	0	471	0.489
Gillnet U.S. Wk 28			1,000	0	0.13	1.00	72	0.1	7.43	0	195	0.126
Gillnet U.S. Wk 29			400	0	0.14	1.00	58	0.2	7.17	0	154	0.130
Sport PT/WR 9			750	30,000	1.20	0.90	250	0.4	0.83	0.05	229	0.699
Sport PT/WR 10			800	40,000	0.75	0.96	187	0.3	1.34	0.06	214	0.525
Sport PT/WR 11			1,900	300,000	1.50	0.97	463	0.3	0.66	0.08	387	0.777
Sport PT/WR 12			700	25,000	0.74	1.00	173	0.3	1.35	0.05	199	0.522

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Stratum	Age	Return year	N_i or $\hat{N}_i$	$V[\hat{N}_i]$	m_i	λ_t	$\hat{r}_i$	ϕ_i	$G(\hat{p}_i)$	$G(\hat{N}_i)$	$SE[\hat{r}_i]$	Prob($m_{ij}>0$)
Troll NW Spring	1.4	2019	16,000	0	1.62	0.99		0.4	0.61	0	253	0.802
Troll NW 1st			95,000	0	1.34	0.96	418	0.3	0.75	0	362	0.737
Troll NE Spring			10,000	0	0.90	0.98	144	0.5	1.10	0	151	0.594
Troll NE Spring 108			500	0	0.45	1.00	84	0.4	2.22	0	125	0.361
Troll NE Spring 108			1,500	0	0.45	1.00	78	0.4	2.22	0	116	0.361
Gillnet U.S. Wk 19			650	0	1.09	1.00	160	0.5	0.91	0	153	0.663
Gillnet U.S. Wk 20			1,200	0	1.61	1.00	192	0.6	0.61	0	151	0.801
Gillnet U.S. Wk 21			3,000	0	2.17	1.00	211	0.8	0.46	0	144	0.885
Gillnet U.S. Wk 22			3,300	0	3.97	1.00	513	0.6	0.25	0	262	0.981
Gillnet U.S. Wk 23			5,750	0	4.09	1.00	465	0.7	0.24	0	234	0.983
Gillnet U.S. Wk 24			7,000	0	6.96	1.00	967	0.5	0.14	0	381	0.999
Gillnet U.S. Wk 25			2,400	0	4.88	0.97	819	0.5	0.20	0	380	0.992
Gillnet U.S. Wk 26			1,300	0	0.54	0.93	189	0.2	1.85	0	256	0.416
Gillnet U.S. Wk 27			1,300	0	0.54	1.00	310	0.1	1.86	0	421	0.416
Gillnet U.S. Wk 28			1,000	0	0.11	1.00	58	0.1	9.22	0	175	0.103
Gillnet U.S. Wk 29			400	0	0.11	1.00	46	0.2	9.04	0	137	0.105
Sport PT/WR 9			750	30,000	1.20	0.90	250	0.4	0.83	0.05	229	0.699
Sport PT/WR 10			800	40,000	0.75	0.96	187	0.3	1.34	0.06	214	0.525
Sport PT/WR 11			1,900	300,000	1.50	0.97	463	0.3	0.66	0.08	387	0.777
Sport PT/WR 12			700	25,000	0.74	1.00	173	0.3	1.35	0.05	199	0.522
Total			336,200	790,000	89		14,848				1768	
Average								0.33				

Standard Error $\left(\sum \hat{r}_i\right)$ = 1,768;   95% Relative Precision $\left(\sum \hat{r}_i\right)$ = 23%

N_i = Total harvest in fishery stratum i

ϕ_i = Proportion of fishery catch sampled in stratum i

r_i = Anticipated contribution of Stikine River fish to stratum i from brood year 2010 (historical data)

m_i = Anticipated number of Stikine River CWTs recovered in stratum i from brood year 2010

λ_i = Decoding rate of CWTs for marked fish in the sample from stratum i

$\hat{\theta}$ = Estimated fraction of the cohort from brood year 2013, tagged with CWTs

p   = $m_i / (\lambda_i N_i \phi_i)$

G(x)   = $CV^2(x)$

Appendix A2.–Preliminary analysis of returns from brood year 2002 Chinook salmon tagged as smolt in the Stikine River in 2004.

Fishery	Year	Age	Per. type	Period	Area	Catch	Var N	mj	rj	ϕ_i	λ_i	G[pj]	G[1/q]	G[N]	SE[rj]	95%RP[rj]
High Seas	2005	1.1				69,908		1	168	60%	1.000	0.994	0.014	0.000	167	195%
DRIFT	2006	1.2	W	24	106	171		1	89	100%[2]	1.000	0.989	0.014	0.000	89	195%
DRIFT	2006	1.2	W	26	106	398		1	251	40%	1.000	0.996	0.014	0.000	251	196%
DRIFT	2006	1.2	W	25	108	3,923		2	273	74%	1.000	0.496	0.014	0.000	193	139%
DRIFT	2006	1.2	W	24	108	5,223		5	1,007	51%	0.984	0.199	0.014	0.000	461	90%
TROLL	2006	1.2	W	25	114	34		1	100	100%	1.000	0.990	0.014	0.000	100	195%
High Seas	2006	1.2				83,103		1	167	60%	1.000	0.994	0.014	0.000	166	195%
DRIFT	2007	1.3	W	19	108	255		2	449	45%	1.000	0.498	0.014	0.000	319	139%
DRIFT	2007	1.3	W	20	108	408		2	334	60%	1.000	0.497	0.014	0.000	237	139%
DRIFT	2007	1.3	W	21	108	899		4	686	59%	1.000	0.249	0.014	0.000	349	100%
DRIFT	2007	1.3	W	22	108	1,316		3	379	79%	1.000	0.331	0.014	0.000	221	114%
DRIFT	2007	1.3	W	23	108	1,729		2	427	47%	1.000	0.498	0.014	0.000	303	139%
DRIFT	2007	1.3	W	24	108	4,933		5	885	58%	0.973	0.199	0.014	0.000	405	90%
TROLL	2007	1.3	P	1	NW	29,540		2	612	33%	0.990	0.498	0.014	0.000	435	139%
TROLL	2007	1.3	P	2	SE	14,395		4	1,041	39%	0.994	0.249	0.014	0.000	530	100%
TROLL	2007	1.3	P	2	NE	13,486		4	878	46%	0.998	0.249	0.014	0.000	447	100%
TROLL	2007	1.3	P	2	NW	19,578		1	271	37%	0.992	0.996	0.014	0.000	271	196%
TROLL	2007	1.3	P	2	107-35	124		1	197	51%	1.000	0.995	0.014	0.000	197	196%
SPORT	2007	1.3		13	-	142		1	102	99%	1.000	0.990	0.014	0.000	101	195%
SPORT	2007	1.3		12	-	145		1	118	85%	1.000	0.992	0.014	0.000	118	195%
SPORT	2007	1.3		11	-	438		2	201	100%	1.000	0.495	0.014	0.000	142	139%
SPORT	2007	1.3		10	-	161		2	226	89%	1.000	0.496	0.014	0.000	160	139%

-continued

[2] ADF&G harvest expansion report indicates that over 100% of the catch was sampled. It was changed to the maximum percent possible, which is 100%.

Appendix A2.–Page 2 of 2.

Fishery	Year	Age	Per.	period	Area	Catch	var N	mj	rj	ϕ_i	λ_i	G[pj]	G[1/q]	G[N]	SE[rj]	95%RP[rj]
DRIFT	2008	1.4	W	20	108	769		1	152	66%	1.000	0.993	0.014	0.000	151	195%
DRIFT	2008	1.4	W	21	108	1,591		7	1,073	65%	1.000	0.142	0.014	0.000	421	77%
DRIFT	2008	1.4	W	22	108	1,396		5	690	73%	1.000	0.199	0.014	0.000	316	90%
DRIFT	2008	1.4	W	23	108	1,538		5	626	80%	1.000	0.198	0.014	0.000	287	90%
DRIFT	2008	1.4	W	24	108	1,267		4	776	52%	1.000	0.249	0.014	0.000	395	100%
DRIFT	2008	1.4	W	25	108	2,258		1	271	37%	1.000	0.996	0.014	0.000	270	196%
TROLL	2008	1.4	P	1	NE	1,455		1	169	59%	1.000	0.994	0.014	0.000	169	195%
TROLL	2008	1.4	P	1	NW	10,799		2	573	36%	0.982	0.498	0.014	0.000	407	139%
TROLL	2008	1.4	P	1	SE	3,319		2	361	56%	0.987	0.497	0.014	0.000	256	139%
TROLL	2008	1.4	P	2	SE	5,881		3	623	49%	0.984	0.332	0.014	0.000	364	114%
TROLL	2008	1.4	P	2	NE	12,623		1	151	67%	0.989	0.993	0.014	0.000	150	195%
SPORT	2008	1.4		11	-	125		1	100	100%	1.000	0.990	0.014	0.000	100	195%
SPORT	2008	1.4		10	-	100		1	102	98%	1.000	0.990	0.014	0.000	102	195%
SPORT	2008	1.4		9	-	58		2	201	100%	1.000	0.495	0.014	0.000	142	139%
SPORT	2008	1.4		11	-	102		3	301	100%	1.000	0.330	0.014	0.000	175	114%
						293,590		87	15,028						1,709	22%

Note: $\theta = 0.01$ based on sample size of 8,350 with 84 tags

Note: Per. Type=Period type: W = week; P = period; B = biweek

APPENDIX B

SPORT FISH DIVISION SALMON CWT DAILY LOG

TAGGING SITE: _____ DATE: _____ PAGE: _____

SPECIES: _____ **Fall Juvenile** or **Spring Smolt** (circle one)

AIR TEMP: Minimum _____ (°C); Maximum _____ (°C)

WATER: Temperature _____; Depth _____ (ft/cm/m)

PRECIPITATION: _____ (in/mm)

MACHINE S/N: _____ HEAD MOLD SIZE: _____

YESTERDAY'S TAGGING

1. TAG RETENTION AND SHORT-TERM MORTALITY EVALUATION

   a. Number held 24 hrs
          _____ (Yesterday's line 7 entry)

   b. Tag Retention
     (Number of positive beeps/100)
          _____ (Test 100 fish)

   c. Mortalities
          _____ (Overnight mortality)

   d. Released Live Today (1a – 1c) x 1b
          _____ (Release)

TODAY'S TAGGING

2. TODAY'S TAG CODE

_____

3. RECAPTURES

_____ (Ad-clipped fish in traps)

a. Total with CWTs
_____ (Release)

b. Number without CWTs
_____ (Tag and Release)

4. NEW CWTs APPLIED:	Trap	Seine
a. Ending Number (Machine Counter)	_____	_____
b. Beginning Number (Machine Counter)	_____	_____
c. Retags (Hand Counter)	_____	_____
d. Subtotal (a – b – c) (Total CWTs Applied)	_____	_____
5. POST TAGGING MORTALITY: (Croakers)	_____	_____
6. NUMBER TAGGED (4d – 5)	_____	_____

7. NUMBER HELD FOR TAG RETENTION AND SHORT-TERM MORTALITY

(sum line 6) _____ (Carry over to next day)

Notes:

Appendix B2.–Smolt age-weight-length data sheet.

SMOLT AWL DATA

Tagging Site: _____ Species: _____ Year: _____ Page: _____

Date	Fish #	Trap or seine	Length, mm FL	Weight, g	Date	Fish #	Trap or seine	Length, mm FL	Weight, g

Appendix B3.–Coded wire tag daily release log

CWT SUMMARY DATA

*Site:*_____   *Year:*_____   *Page:*_____

Date	Chinook Released w/CWT		Coho Released w/CWT	
	Daily	**Cum**	**Daily**	**Cum**